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CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

Berkeley, California

Stephen N. Wyckoff, Director

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Station's Annual

May 1948

ANNUAL REPORT OF THE

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION[1/]

1947

FOREWORD

This report of the work of the California Station, designed for official rather than public reading, accounts for the work of each of the eight divisions of the Station. In each case, the objectives for the year are stated, the accomplishments are discussed, and a series of objectives for 1948 is given.

In three divisions - Fire, Range, and Influences Research - the primary objectives for 1947 were to bring projects under way to definite completion, analyze and interpret the data, and to progress as far as possible toward the publication of results. These objectives were met.

In Fire Research, field work, analysis, and interpretation of data were completed for the Fire Damage Appraisal study of the four national forests of southern California. This was a larger job than was originally contemplated, but the results will be in the hands of the Regional Office and the national forests by the middle of 1948. Other papers for publication will be made ready during the year.

The Division of Range Research has completed two major field projects under way for a number of years: long series of experiments at the San Joaquin and Burgess Spring Experimental Ranges. The manuscript on the San Joaquin Range work is nearly ready for publication and will be completed somewhat before the Burgess Spring manuscript.

Under the stimulus of State cooperation and financial aid, the Division of Forest Influences has made good progress in analysis and interpretation of a large volume of data representing a number of years of work. Several manuscripts based on this work are now nearing completion.

For these three divisions, the completion of work under way for a number of years will present a needed opportunity for new problem analyses with resulting careful selection of new projects.

1/ Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California at Berkeley, California.

The field season of 1947 marked the end of eleven consecutive years of experimental logging on the Blacks Mountain Experimental Forest. For the next few years logging experiments will be conducted in sugar pine types at the Stanislaus Experimental Forest, after which it is planned to continue logging at Blacks Mountain. Work has begun upon the compilation of the Blacks Mountain data, leading to publication of the results.

Despite numerous difficulties stemming from the loss of personnel and limitation of program because of decreased funds, the Forest Survey made considerable progress during 1947. The planned objectives were not reached, however, and this necessitates revision of the program for the future. The greater values to be gotten through intensification of survey data, as demonstrated by the State cooperative survey project, have proved to be of particular interest to many organizations and individuals in the State.

Completion of the first part of a study of the economics of blister rust control by the Division of Forest Economics has drawn together many valuable viewpoints and has led indirectly to the setting up of the sugar pine logging experiments on the Stanislaus Experimental Forest.

The Division of Forest Genetics has been able to continue the development of new crosses, the more fundamental studies and the efforts to produce more seed of established hybrids for field tests. Publication of results has been kept up to date. It becomes increasingly apparent that radically new methods of mass hybridization will be necessary to produce the volume of hybrid seeds wanted, and to lower their cost. In this field the interesting possibility of vegetative reproduction of hybrids will be given consideration and trial.

The development of a large pulping operation and the great increase in the number of plywood plants in the State, as well as growing interest in the so-called minor species, has provided the Forest Utilization Service with expanding opportunities. Many difficulties in the use of minor species - white and red fir and the local hardwoods - have centered around failures in seasoning. In this field the Service has been able to use the knowledge of its staff and of the Forest Products Laboratory to good advantage. Further expansion of seasoning work and calls for more information on other species and products, particularly veneer and plywood, are to be expected.

The Division of Flood Control Surveys has made good progress in completing the backlog of unfinished surveys in southern California. It has also assisted the Soil Conservation Service in some surveys for which that agency had responsibility. Several new surveys have been started, and the survey of the Willamette River watershed will probably be undertaken soon. This drainage, differing markedly in precipitation pattern and in type of vegetative cover from most California watersheds, will bring new and interesting problems to the Division.

As shown by the division reports, the efforts of the Station in several fields of work have been materially strengthened by allocation of cooperative funds from other agencies. The work of the Station has also benefitted from less formal but greatly valued technical advice and other assistance from national and local sources. As in past years, the Regional Office and national forests, the University of California, the State Division of Forestry, and other agencies have aided the Station in its work.

FOREST MANAGEMENT RESEARCH
(Duncan Dunning, Chief of Division)

Forest Management research in 1947 was restricted to the eight activities of the program listed below as jobs for the year:

Objectives

1. Establish the final test series for the Blacks Mountain ponderosa pine conversion cutting, logging approximately 5 MM board feet.

2. Prepare management recommendations for mixed types from results of long-term plots.

3. Complete revision of growth prediction chart.

4. Complete volume table revisions.

5. Report results of plantation surveys with recommendations. Continue minor going experiments and start growing stock for later tests. of species previously receiving inadequate attention.

6. Establish field trials of stand improvement in young growth. Re-examine series of older thinning plots.

7. Assist in planting of hybrid stock if undertaken.

8. Continue assistance to various forest agencies in applying research results.

Activities and Accomplishments

Ponderosa Pine Conversion Cutting

In 1947, 4,676 M board feet were logged from the experimental forest. Stumpage was the highest received to date: $10.55 for ponderosa and Jeffrey pines, $5.80 for white fir and incense cedar. This was the fourteenth year since the working plan was begun -- the eleventh season of experimental logging; the tenth and final series of cutting tests was established.

The object of this project is to test the value of research hypotheses in converting old-growth ponderosa pine to regulated stands that will yield 75 to 80 percent of site capacity. The Experimental Forest approximates 10,000 acres of sites III-125 and IV-100. The plan, in brief, was to set up the ideal regulated stand structure aimed for, and to approach this goal by:

(1) Reducing insect drain to a tolerable rate by a light preliminary sanitation-salvage cut based on a tree-by-tree risk marking according to susceptibility ratings formulated by Salmon and Bongberg of the Bureau of Entomology and Plant Quarantine.

(2) Following immediately with harvest-improvement cuttings varying in number, interval and intensity according to local stand conditions, species requirements, and production goals. These treatments include group cuttings to release advance growth, group reproduction cuttings synchronized with seed bearing and ground preparation, and selective utilization of high-value old trees and currently developing high risk trees. Constantly in mind is the desirability of carrying a substantial reserve as long as possible in appropriate locations to alleviate the reduction of cut that ultimately will be necessary because of the near absence of intermediate size classes.

(3) Thinning and pruning dominant trees in the advance growth, after planned release in logging, to build up deficient size classes with trees of good quality.

(4) Continuing comparisons, on a plot basis, of other formalized (mostly single-cut) conversion systems.

(5) Comparing output and operating costs of the several cutting systems.

In the 11 years of operation all but 451 of the 8,977 timbered acres have been cut over from one to three times. Cutting removed 46,431 M B.M. of the original 167,806 M B.M. The volume removed ranged from about 1,600 to 17,000 bd ft.per acre, the average being 5,450 bd. ft. The reserve on the cut-over land averages 13,000 bd. ft.

The insect control aspects of the cooperative experiment with the Bureau of Entomology and Plant Quarantine have been very successful. Between 1933 and 1936, before treatments were begun, bark beetle damage was of epidemic proportions, somewhat above 200 bd.ft. per acre yearly in virgin timber, and exceeded growth by 76 bd.ft. During the 10 years of treatment beetle damage declined generally, reaching the lowest point of record — 18 bd.ft. to the acre — in 1944. A minor up-swing occurred between 1938 and 1940 and damage has increased slightly since 1945. During the 10-year period 1937-47, loss rates on the areas subjected to high risk cutting have been consistently much lower than on the uncut areas. Comparisons, eliminating the influence of reduced volume exposed to attack, show that the stands with susceptible trees removed, experienced loss rates for the first year only 5 percent, and for the sixth year, only 17 percent as high as rates for virgin timber. Gratifying as these results appear, the final chapter on silvicultural insect control must await experience with the insects in the rising phase to epidemic populations.

As for improvements in stand structure, naturally the results for the short period on these poor sites are not spectacular. With losses reduced to inconsequential volumes of 2 to 13 bd.ft. to the acre a year and in-growth not yet effective, net growth on the cut-over lands has varied almost directly with the volume of old growth reserved, averaging from 60 to 150 bd.ft. per acre annually. It is of interest to note that the heaviest of these very old reserves, merely through loss reduction, are growing at net rates slightly in excess of the estimated capacity for regulated stands. Such heavy reserves, however, necessitate almost complete sacrifice of any harvest for the logger. Although much of the advance growth is far beneath the lower merchantable size limit, 57 percent of the forest is well stocked; hence, ingrowth, which is now contributing only 25 to 30 bd.ft., will become increasingly important. This prospect, coupled with expected improvements as older trees are reduced, suggests that income under good management may be better than present yield tables indicate for such land. Such an outcome would be encouraging to the owners of some four million acres in this type of forest.

A discouraging aspect of stand regulation is the little progress made toward establishing natural reproduction. Failure of seed crops has prevented reproduction cuttings of the type originally planned. Fortunately the abundance of advance growth made it possible to maintain log production through release cuttings, without depleting seed trees where they will be needed when a seed crop is borne. The uncertainty of seed crops reaffirms the importance of supplemental planting in sustained yield operations.

Improvement of stand structure and quality by thinning and pruning crop tree dominants in the advance growth was undertaken for the first time this year. Three randomized blocks of 8 plots each were treated in 4 degrees of thinning. The crop trees on 25 plots and 37 additional acres were pruned in 4 degrees of crown removal.

Comparisons of the conversion cutting systems on a plot basis are provided in a series of ten annual randomized blocks, the final one being established this year. The period of record is too brief to admit conclusions as to the relative merits of these methods of stand conversion.

Output and operating records have shown that the several variable Blacks Mountain conversion cuttings do not reduce log production nor greatly increase logging costs if a good road system is available and its cost is charged off over the period of utilizing the original old growth.

Logging will be discontinued at Blacks Mountain for perhaps two years, beginning in 1948, to reserve remaining portions of the experimental area for treatment when insects become epidemic, to await a heavy seed crop favorable for reproduction cuttings, and to permit use of the logging equipment in a mixed-conifer stand conversion test in the Stanislaus Experimental Forest. In the meantime, stand improvement, loss inventories, and the records of established experiments will be continued. A general report for the first 10 years of the project is being prepared.

Mixed Conifer Management

Principal progress toward mixed-conifer management recommendations in 1947 was made on the old-growth cutting phase of the sugar pine-fir type on high quality sites. Tentative recommendations were outlined in sufficient detail to enable starting a field trial at Stanislaus Branch in 1948.

The urgency of revising and intensifying our mixed-conifer management is underscored by recent summaries of cut-over land records for the Stanislaus area dating back 18 to 38 years. These records show that any single-cut method of stand conversion seldom results in satisfactory growth, accomplishes restocking or prevents loss of soil to brush. The areas under continuous observation — in this instance, good sugar pine land — remain less than one-third stocked with young growth of poor distribution, 95 percent of it fir and cedar. On an area basis, one large sample shows 52 percent of the ground usurped by brush and but 16 percent held by tree reproduction.

Field and office plans for the Stanislaus experiment were completed during the fall and winter. The aim is to test on one area the combined effects of conversion treatments suggested by studies of separate aspects of mixed-stand silviculture. The primary objective is to establish sugar pine reproduction and bring it through to merchantable size. Sufficient volume of premium quality wood must be grown to compensate for costly special measures necessary to meet that objective. These measures include group seeding cuts, ground preparation, brush eradication, rodent control, blister rust control, one or more release cuttings, supplementary seeding or planting, two or three thinnings, and crop tree pruning. The experimental area is of high site quality with a heavy old-growth stand running 86 M B.M. to the acre of which 35 M B.M. is sugar pine. Two or three million feet will be cut prior to September 30 in advance of an indicated heavy seed fall. Indispensable aid for this project is being given by Region 5 and the Office of Blister Rust Control.

In the Feather River center, young growth phases of stand conversion research were directed toward improving stocking, composition, quality and rate of growth in 5-species mixtures of moderate sites. First experiments in this area were begun in 1920 on a limited scale and have remained on a field maintenance basis until 1947 when funds permitted moderate expansion.

The early experiments represented four degrees of thinning, even the heaviest of which resulted in little growth response. There is considerable evidence that early mining, lumbering, burning and overgrazing prior to establishment of the local national forest caused site deterioration that masks the effects of thinning. The work in 1947 was designed to determine whether continuing slow growth is a result of site deterioration or whether the thinnings gave insufficient relief from competition. Half of each plot in the series was retreated giving complete release to crop-tree dominants at the rate of 100 to the acre with average diameter 8 inches. Half the crop trees on both thinned and check areas were pruned.

The abundant slash from these drastic thinnings caused a heavy concentration of engraver beetles (Ips) and as a precautionary measure, the crop trees were sprayed with the insecticide, DDT. No trees have died thus far.

In the Challenge Experimental Forest a serious obstacle to young growth improvement is the presence of unmerchantable hardwoods. Chopping or other mechanical control of these aggressive weed trees is costly and ineffective. Chemical control offers considerable promise, hence tests were begun to determine specific and seasonal susceptibility of tan oak and madrone to 2,4-D and the seasonal low point in sprouting vigor. Treatments at monthly intervals are being continued until the annual growth cycle is complete.

Growth

Revision of the selection stand growth predicting mechanism, first prepared in 1933, was suspended July 1 by curtailment of funds. Prior to suspension, records for 206 of the 35-year-old mixed conifer plots were partially compiled revealing two points of interest. First, the predicting procedure gave estimates of growth very closely in accord with actual growth in the field for both 20-year and 35-year periods. Estimates of yield, therefore, can be made from the charts with considerable confidence. Revisions, when resumed, should be directed to improving the individual species yield estimates rather than complete overhaul of basic methods.

The second point revealed by partial analysis is that the growth rate of the merchantable reserve has not declined appreciably over the long period, contrary to experience in other regions. Net growth after 35 years remains about the same as for the first 20 years.

Disturbing aspects are that net growth is only about one-third of site capacity, that the in-growth contribution remains relatively low, that losses in the merchantable stand increased about 10 percent for the longer period, and that the proportion of less valuable species is increasing.

Volume Tables

Revision of volume tables to the form class basis has proved to be a larger job than was hoped for a year ago. This became apparent from two developments, first, that upper tree taper is strongly related to form class and, second, that a single generalized taper formula does not give accurate volume estimates for several major species. Separate taper and volume tables were, therefore, completed for the two most valuable species, ponderosa pine and sugar pine. These two tables show very low aggregate and standard deviations promising improved volume estimates for small lots of timber — an advantage in sales by tree estimates and in appraisals.

The large amount of volume table services obviously needed and frequently requested by numerous agencies constitutes an insurmountable task for the small mensuration force presently available.

Planting Research

The report on the previously completed plantation survey is being revised. A discussion with Region 5 of the recommendations for future planting is planned for the near future.

Records were maintained for the numerous small planting tests under way. Experiments designed to develop 1-0 stock as a cheaper substitute for standard 1-1 gave preliminary indications that 1-0 nursery stock, though somewhat lower in survival than 1-1, can be used under favorable conditions, such as the fresh timber burn near Challenge Experimental Forest. Root pruning the 1-0 seedlings resulted in no advantages in survival over unpruned stock. However, 2-0 ponderosa pine stock root-pruned in place gave as good second-year survival as standard 1-1 stock and is cheaper to grow.

Final examinations have been made and the report is being prepared for the cork oak field planting tests.

Improving Young Growth

This subject is discussed under ponderosa pine conversion cutting and mixed-conifer management.

Hybrid Pine Test Planting

Small nurseries were prepared at Feather River and Stanislaus work centers to grow out-planting stock from 8,700 seeds of six hybrid pines received from the Institute of Forest Genetics. One-third of the seed was sown in the fall at Stanislaus and two-thirds was stratified for spring sowing at Feather River. Stock should be available for field tests in the fall of 1949 and spring of 1950.

Assistance to Forestry Agencies

Requests for assistance from forestry agencies, industries and land owners covered a wide range of subjects as diverse as how to produce and harvest redwood burls and where to find a continuous supply of pole timber. Most inquiries related to volume tables, growth estimates, planting, and Christmas tree culture. Many requests were readily satisfied from material in our records or from personal experience of members of the Division. Hallin began summarizing information on redwood silviculture available when research in this type was suspended. Least satisfactory was the limited ability to supply tables of all kinds in terms of special products and utilization standards. In most instances ample data are on hand to meet such needs if measurements could be processed. The rapidly increasing interest in forest management warrants strengthening the Division's services.

Plans for 1948

The following jobs are planned for 1948 on the assumption that finances and personnel will be about the same as for 1947:

1. For ponderosa pine conversion cutting trials,

a. Extend thinning and pruning experiments in young growth at Blacks Mountain by establishing a second series of test plots in additional age, size, and stand-density classes freed of old growth by the 1947 logging.

b. Maintain loss, growth, and other records for the experimental forest and permanent test plots.

c. Process for a progress report, the records from the past 10 years of cutting experiments at Blacks Mountain.

2. For mixed-conifer management studies,

a. Complete the first conversion cut of the Stanislaus experiment with special attention to areas ready for restocking with sugar pine in 1948.

b. Encourage wider application of principles underlying the Stanislaus sugar pine-mixed conifer cutting.

c. Establish remainder of plots in the yearlong series of hardwood eradication experiments for young-growth mixed conifers at Challenge Experimental Forest.

d. Analyze 15- to 25-year records for a progress or final report on 14 thinning plots at Feather River, last measured in 1947.

e. Assemble records for a general report on mixed-conifer management.

3. For mensuration work,

a. Complete and publish the form-class volume tables for ponderosa pine and sugar pine.

b. Complete other most urgently needed tables for commercial conifers, particularly white fir, as available funds permit.

c. Resume preparation of the long-delayed growth report for selection stands.

4. For planting research,

a. Grow hybrid pine nursery stock for field testing in the fall of 1949 or spring of 1950.

b. Publish the cork oak plantation report.

c. Complete the revision of the plantation survey report.

d. Analyze for publication, records of planting experiments completed in the last decade.

e. Compile for publication, records of natural regeneration studies.

5. Continue assistance to forestry agencies, industries, and individuals.

FOREST GENETICS
(W. P. Stockwell, Chief of Division)

Objectives

1. Production of hybrid seed for field tests, particularly crosses of ponderosa pine, of lodgepole-jack pine, and of Jeffrey-Coulter pines.

2. Develop plans for field tests of hybrids in cooperation with Region 5.

3. Continue timber pine hybridization, making new crosses as well as checks and repeat crosses necessary to confirm previous work.

4. Continue phylogenetic studies to provide basic data for planning hybridizing program.

5. Continue oleoresin studies.

6. Continue studies of methods and techniques used in hybridizing to increase safety and efficiency and to reduce costs.

Activities and Accomplishments

Mass Production of Hybrid Seed

Because most pines require two seasons and the remainder require three seasons to mature seed, the results of the 1947 crossings are not yet known. In 1946 when seed production for field testing was first undertaken many new and previously unused seed trees had to be selected. Some of these failed to produce any seed either from open wind pollination or from hand pollination. Others produced light crops and still others bore normal seed crops. Attention was thus forcibly drawn to the need for selecting numerous seed trees that can be depended on to mature a crop consistently each year. Because of these difficulties the seed crop from the 1946 pollinations was light. There were approximately 33,000 seeds or a few more than 30 seeds per pollination bag — a very low average. The hybrids represented were:

Pinus	ponderosa	x	apacheca
Pinus	ponderosa	x	arizonica
Pinus	ponderosa	x	scopulorum
Pinus	Jeffreyi	x	(Jeffreyi x Coulteri) backcross

In 1947 the poorest of the previously used seed trees were discarded and new seed trees were selected for trial. Seven crosses were made using 1550 pollination bags (table 1).

Table 1. Mass production of hybrid seed for field testing.

Seed parent	Pollen parent - Number bags used										Total bags
	P. ponderosa var. scopulorum	P. apacheca	P. arizonica	P. Jeffreyi x P. Coulteri	P. strobus	P. excelsa	P. Banksiana	P. Murrayana			
Pinus ponderosa	250	250	200								700
Pinus Jeffreyi				100							100
Pinus Murrayana							100				100
Pinus Banksiana								50			50
Pinus strobus						50					50
Pinus excelsa					50						50
Pinus monticola					250	250					500
											1550

Field Tests of Hybrids

The Forest Management Division of this Station undertook the planning and execution of field trials of hybrid stock, and the Genetics Division gave the seed to be tested to H. A. Fowells. Further details will be found in the report of Forest Management Research.

Timber Pine Hybridization

New crossing experiments, checks, and repeat crossings were continued in the timber pine group. As a part of this work 600 seedlings from the 1946 nursery (1944 pollination program) were transplanted to the hybrid section of the Eddy Arboretum for further observation and to provide material for future backcross and F_2 breeding work. The hybrids outplanted are given below, the seed parent listed first.

Pinus echinata	x	rigida
Pinus echinata	x	taeda
Pinus rigida	x	taeda
Pinus rigida	x	echinata
Pinus monticola	x	Griffithii
Pinus monticola	x	strobus
Pinus strobus	x	Griffithii
Pinus Murrayana	x	Banksiana
Pinus ponderosa	x	apacheca
Pinus ponderosa	x	scopulorum
Pinus ponderosa	x	arizonica
Pinus washoensis	x	ponderosa

Hybrid seeds resulting from the 1945 pollinations were planted in 37 nursery tests arranged to facilitate observation and collection of statistical data. Among these (listed below) were seed of four new hybrids; three backcrosses and one F_2 undergoing their first nursery test.

Pinus echinata x (echinata x caribaea)
Pinus echinata x (echinata x taeda)
Pinus (echinata x taeda)F_2 interpollinated
Pinus (Murrayana x Banksiana) x Banksiana

The 1947 program of crossing timber pines included small-scale attempts to make 65 different hybrids. Some had failed previously, some were repeats of previous successes done to learn whether the cross could be made at will with the same results. Of the total 27 were crosses not previously attempted. These will be tabulated in a future report when results are available.

Phylogenetic Studies

In the phylogenetic studies 27 crossing attempts were made, all on a small scale, using approximately 200 bags. Seed from the 1946 crossings in the closed cone group have been collected, and if water is available they will be planted this spring. Preliminary results will be available for the next annual report, it is hoped.

Past tests have shown that hybrid vigor results from crossing closely related species pairs that differ in minor respects such as P. strobus and P. monticola; P. ponderosa and P. apacheca; P. Murrayana and P. Banksiana. Other species pairs that show approximately the same degree of general similarity with minor differences whether judged by chemical, cytological, morphological or other criteria are being selected and tested as fast as possible. The importance of this phylogenetic work may be emphasized by stating that at the present rate of approximately 50 new crossing attempts per year, about 80 years would be required to try the possible species crosses in the genus Pinus. By adding in the backcrosses and other multiple hybrids the task, and opportunities, may be expanded to infinity.

Pollen samples for crossing attempts have been received from the Northeastern and Southeastern Forest Experiment Stations, from Dr. Syrach-Larsen of Copenhagen, Denmark, and from Dr. A. J. Riker of the University of Wisconsin.

Oleoresin Analysis

Studies of the oleoresins of pines were continued in cooperation with Dr. Haagen-Smit of the California Institute of Technology. Analyses were made of the oleoresins of Pinus strobus, P. albicaulis, P. canariensis, P. washoensis, and P. radiata. As the analyses accumulate some interesting phylogenetic inferences may be drawn and tentative conclusions reached to form the basis for breeding tests. It is of importance in breeding work that such morphologically similar pines as strobus and monticola can be distinguished by the presence of undecane in the latter and that the similar canariensis and longifolia pines can be distinguished by a simple color test. By such tests the determination of hybrids as well as of species becomes precise even on young stock.

Collected or received from cooperators and awaiting critical examination are samples of oleoresin from six pine species. The Southeastern Station contributed a sample of P. taeda from Florida, collector not known, and a sample of P. virginiana from South Carolina collected by Dr. George Hepting. Mr. H. D. Bruce, formerly with this station and the Madison Laboratory, sent a sample of P. parviflora from Japan. Professor Tschermak, of Vienna, sent a sample of P. cembra from Austria and P. Balfouriana and P. Lambertiana were collected locally by staff members.

Methods and Techniques

Refinement and improvement in methods and techniques is continuous but not marked by any outstanding innovations.

While tree climbing carries with it certain hazards there have been no injuries from this source in 1947. The men who climb understand the hazards and any new men employed will be carefully instructed in safety methods. It is believed that a light sectional ladder of aluminum or suitable alloy for use in climbing large trees will promote safety. Such a ladder will be purchased when funds are available.

Another study that may increase safety of tree breeding work is under way. Trees have been planted at wide spacings and will be topped and trimmed in an effort to produce a tree that bears its flowers low enough that they can be worked with from the ground or from a low ladder.

Other Activities

In addition to the specific work proposed in the 1947 annual report, progress has been made on several old lines of work and some new work was undertaken as opportunity offered.

A study of character segregation and clonal differences was started using an F_2 population of the hybrid attenuata x radiata. To start with, 1500 cuttings from 125 F_2 segregates were rooted. Later 10 rooted cuttings each from 40 of the clones were outplanted for study. It was soon evident that the rooting ability of cuttings from different hybrid trees varied from 0 to 100 percent. A later recheck indicated that this variation is relatively constant and of genetic nature in this hybrid. (A. G. Snow Jr. has reported similar results for Pinus strobus). By using these clones of known rooting ability, the various techniques for rooting cuttings can be subjected to more precise tests and evaluation than has been possible in the past. This work may open the way for eventual selection of strains of forest trees suited to reproduction by vegetative means.

Considerable discussion has resulted from the oleoresin studies. The idea has been advanced that the variation between oleoresins from different races or even different trees might be sufficient to invalidate this method of evaluating relationships. To check this possibility a series of optical properties tests will soon be run on oleoresin collected from 130 sample trees of Pinus ponderosa during the summer of 1947. Racial differences will be investigated later.

The work on longleaf pine done at the Southern Station was the inspiration for a test of the effects of fertilization on the growth and flower production of ponderosa pine. Three blocks of 16 trees each planted at 7½-foot spacing were selected. The trees were ponderosa pine eleven years old, and in each block all of the trees were from the same seed tree the same crop year. To each block of 16 trees the following amounts of fertilizer were applied in April 1947:

Amonium sulphate . . . . . 36 lbs.
Superphosphate . . . . . 40.5 lbs.
Potassium phosphate . . . . 18 lbs.

Results the first season were unexpected. There was a great increase of weed and bracken fern growth but there was no observable effect on the trees. The test will be continued for another season.

Innoculation of the Institute white pine beds with Wisconsin soil has not improved the white pine seedlings. It was hoped that the introduction of mycorrhiza might improve the growth of white pines at Placerville; no positive results are evident to date.

Each year more cooperative work is done. This includes testing of hybrid trees for blister rust resistance by the Region 5 Division of Forest Pathology and the University of Wisconsin; the testing of hybrids for insect resistance by the forest entomologists of the Bureau of Entomology and Plant Quarantine; and the exchange of information, seeds, plant material, pollen and oleoresins with numerous cooperators in this and foreign countries.

Mr. James G. Eddy, founder of the Institute, provided funds for making a thirty-minute color film with printed titles to record the pine breeding activities. The film was planned and directed by R. H. Weidman and photographed by Paul Fair of Region 5.

Plans for 1948

1. Continue mass production studies, particularly the search for more seed trees that consistently produce good seed crops. The mass production pollinations will be reduced this year so that more experimental crossings may be made.

2. Increase the timber pine experimental work, emphasizing crossings within the southern pine group. The particular species to be used will depend on the pollen and cone production of southern pines growing at Placerville.

3. Continue the phylogenetic crossings, doing what work is possible in the closed cone group and also crossings to test the affinities of P. Torreyana, P. canariensis and P. longifolia.

4. Examine the oleoresins of P. parviflora and P. cembra and of other species if available and time permits.

5. Continue the clonal studies of the hybrid P. attenuradiata F_2 population, adding other hybrids to the test as they become available.

6. Complete old projects and undertake new work in line with the long-time program as circumstances indicate and funds permit.

Note: Because of water shortage, the nursery work must be curtailed. This will affect the results immediately available from all of the hybridization work.

FOREST FIRE RESEARCH
(C. C. Buck, Chief of Division)

Objectives

Plans for 1947 included these specific objectives:

1. Fire Damage Appraisal: Complete the project, with Fons and Countryman devoting practically full time and Buck spending half time or more on this work.

2. Chemical Control of Forest Vegetation:

a. Continue spray studies on a limited scale, emphasizing intensive experiments on a limited number of California brush species and confining treatments to the salts and esters of 2,4-D.

b. Complete the text for Laboratory-Station publication, with Bruce and Buck summarizing the recommended uses of chemicals for different forest vegetation control problems and Blanchard assisting in preparation of the section on use of translocated chemicals.

3. Ignition Time and Ignition Temperature Study: Obtain laboratory data necessary for completion of the study. Fons will devote any time that can be spared from the fire damage appraisal to this study; results will be published as soon as all data can be completely analyzed.

4. Forest Fire Behavior and Control: Resume field and laboratory studies of long-term program as rapidly as men and facilities become available.

Activities and Accomplishments

Fire Damage Appraisal

Compilation of damage estimates for the 225 appraisal units included in the four southern California national forests was completed during the year. This project, designed to provide a practical method for estimating the flood and erosion damages resulting from fire, was undertaken in 1945 jointly by the Forest Influences and Fire Divisions. The individual national forests concerned also participated to the extent of inventorying all of the up-stream improvement values susceptible to run-off and erosion damage and classifying the values according to their susceptibility to damage.

There is not yet sufficient information on the hydrologic characteristics of the southern California watersheds to permit valid estimates of the effect of fire on underground water supplies or on total stream flow. The present estimates, therefore, do not include this important aspect of damage. It was possible in some cases to compute damage to water supplies drawn from stream diversions where damage takes the form of interruptions of service during storm periods.

Typical damages on the coastal plain side of the Angeles and San Bernardino National Forests have been found to range from $3 to $5 per acre for small fires, and up to $100 to $500 per acre for larger fires. As indicated in last year's report, increased erosion following fire, which results in larger costs for handling and storing debris, is the largest single element of damage encountered. The tables now being prepared for field use itemize the expected damages for up-stream areas, for down-stream overflow areas, for debris storage and removal, and for water supplies from stream diversions where these have been inventoried.

Compilation of run-off and erosion data employed in the damage appraisal study was undertaken with the assistance of part time help furnished by the Forest Influences Division. The data will be ready for publication by the Influences Division when the compilation and checking are completed in February.

Chemical Control of Vegetation

Field experiments with spray chemicals for the control of California brush species were limited to the spring months of 1947. Work was also restricted to the study of 2,4-D since study had already shown that ammonium sulfamate, though quite effective as a contact herbicide, has little permanent effect on sprouting species and is too expensive for general broad-scale use. Prior to the growing season, several hundred individual shrubs of various species were cut off above the ground. After sprouts developed in the spring, these shrubs were treated with one or more forms of 2,4-D. Freshly cut stems and a few girdled tree stems were also included in the spring treatments with 2,4-D.

Loss of Blanchard, who had been devoting full time to this work, automatically removed the "control of vegetation" study from active status at the end of June. However, follow-up inspections of these 1947 experiments, as well as most of the 1945 and 1946 ones, were made by remaining members of the staff late in the season in conjunction with other work. One more inspection of the 1947 treatments will be required to conclude this particular phase of study.

Results of the study can be made available for possible field application after this final inspection is made and analysis of the data can be completed. Preliminary indications are that 2,4-D is no panacea, but that it may provide a practical means for controlling some troublesome species.

No progress was made toward completion of the Laboratory-Station publication summarizing recommended practices for chemical control of vegetation. At the time of his departure for Japan, Bruce transmitted the manuscript in its original rough draft stage back to Buck. The loss of Blanchard at about the same time made it impossible to complete the section on translocated chemicals as had been planned, and the paper as a whole had to be set aside.

Ignition Time and Ignition Temperature Study

Fons, working alone and mostly at night, completed the analytical and laboratory phases of the ignition study. The results make clear some of the fundamental relationships causing forest fire behavior phenomena that have heretofore been only partly explained.

Specifically, the study shows that the surface temperature of wood when flame first appears is nearer 650° F. than to 540° F., the temperature usually quoted. Another finding is that wood fuels as small as 1/8-inch in diameter ignite while they still have significant amounts of moisture in them. The study has provided an explanation of how the amount of heat required to bring given fuel particle to ignition temperature is controlled by a number of physical factors pertaining to the fuel and its environment. It explains, too, how ignition time varies with rate of heating, moisture content, fuel-particle size, and other factors.

A manuscript describing the study is being prepared, and will be submitted for publication after technical review of analytical procedures and interpretation laboratory data are completed.

Forest Fire Behavior and Control

Insufficient funds again made it necessary to postpone resumption of the regular long-term program of Fire Behavior and Control Studies. In their place, all 3 members of the Division devoted most of their time during the year to the Fire Damage Appraisal Study, with the Region helping to pay their salaries and expenses.

Buck spent several weeks in helping the University of California School of Forestry organize the first of a planned series of courses in forest fire protection. This included both assistance in development of the teaching program and in supplying appropriate instructional material. He and Fons have also devoted considerable time to the development and presentation of fire training material for regional personnel at the professional fire-specialist level. Both worked from time to time with the Arcadia Fire Control Equipment Development Center in developing a research program on water and chemicals and their application in forest fire control.

Plans for 1948

1. Fire Damage Appraisal: Supervise reproduction of the damage tables and necessary maps for distribution, and complete the instructions necessary for their application. Prepare a brief article for publication, describing the methods used in arriving at the estimated damage figures.

2. Chemical Control of Vegetation: Inspect the plots treated with 2,4-D in 1947, analyze the data pertaining to 2,4-D, and complete the Laboratory-Station manuscript.

3. Ignition Time and Temperature Study: Secure technical review of the analysis and conclusions and complete the manuscript for publication.

4. Forest Fire Behavior and Control: Resume field and laboratory studies schedules in the regular long-term program as rapidly as men and facilities become available. In the meantime, devote most effort to analysis of fire behavior data already on hand, and particularly that pertaining to the behavior and measurement of the weather and fuel factors and control rate of spread. Some of the results are planned for publication. Continue work with the Fire Control Equipment Development Center on the water-use study in an advisory capacity whenever called on, and take an active part in the work when opportunity permits.

FOREST ECONOMICS
(A. E. Wieslander, Chief of Division)

Objectives

1. Forest Survey

Inventory

a. Prepare a field manual covering classification of aerial photos, field sampling procedures, and species-type and site mapping operations.

b. Analyze plot volume data and crewtime records for more precise allocation of plots and improved accuracy of estimates where possible.

c. Revise the inventory work plan.

d. Complete the field inventory (mapping and sampling) of at least half of the remaining commercial timberland areas.

e. Crystallize procedure for compiling areas and volumes by punch cards and complete the compilation of area and volume statistics for at least two main timbered counties.

f. Develop procedures for deriving area measurements from maps, and cooperate with the BAE in assembling map showing land ownership.

g. Plan the Survey's county statistical and sub-region analytical reports; prepare Siskiyou and Trinity County reports for release; and assemble general descriptive material for one or more sub-region reports.

h. If State funds become available, cooperate with the State in survey intensification work.

Drain and Requirements

i. Conduct the yearly commodity drain survey for all forest products except fuelwood, fence posts and split products.

j. Prepare supplemental plan for conducting the drain survey of items excluded under "i".

k. Submit to Washington a preliminary plan of special studies for the evaluation of woods waste as a factor in total commodity drain.

l. Collaborate with Pacific Northwest and Northern Rocky Mountain Stations in recommending necessary changes for present volumetric converting factors for minor forest products.

m. Complete preliminary working plan for requirements work, and conduct studies of wood used in residential and farm construction.

n. Prepare preliminary plan and start work for estimating non-commodity drain.

2. Census and RPS

a. Take required data for the annual census of lumber production, and obtain new data needed for the commodity drain survey.

b. Continue RPS work until March 31, or longer if required.

3. Forest Economics Research

a. Complete the problem analysis for the forest economics field.

b. In cooperation with other Divisions, identify major economics content of existing and potential work center projects.

c. Guided by the problem analysis, select work center projects of highest priority and develop work plans for their economic phases.

Activities and Accomplishments

Considerable progress in all major Division programs was made during 1947, but certain details of the scheduled jobs could not be fully carried out. Both reduction of Federal funds and cooperative work contracted with the State necessitated some changes in field crews and work assignments during the year. Then too, unexpected storms in October closed the high country to field sampling. As a result work planned for the Inventory was affected as follows:

The field inventory (mapping and sampling) was completed for 38 percent of the timberland area, thus falling considerably short of the planned 50 percent.

The installation of punch card equipment and the compiling of area and volume statistics for at least two timbered counties was not carried out because of the reduced field sampling and consequent gaps in coverage.

Nothing could be done toward preparing the planned Siskiyou and Trinity reports since gaps in the coverage prevented compilation of the statistics. No work was done in the planning of statistical and analytical reports because of other more pressing jobs. However, Jensen did prepare a paper on "Subject matter and organization of analytical reports" for the Second Techniques Meeting held at Eagle River, Wisconsin, which will be helpful when this planning is done.

Specifically, the more important accomplishments were:

Forest Survey -- Inventory

All of the plot data taken to the beginning of the 1947 field season were analyzed. This analysis determined 3 plots at a location to be the optimum number, saving 20 percent in field time as against 2 plots per location. It also determined that 3,375 plots taken at 1,125 sampling locations will give a sampling error of 1.71 percent for the State, safely under the allowable 2.41 percent. The optimum spacing of sampling locations for each of 16 age-density classes was worked out. The analysis

indicated also that intensifying mapping from a 40-acre minimum unit to a 4-acre minimum would reduce the number of sampling locations from 1,125 to 878 and still maintain the accuracy of 1.71 percent. This finding should be useful in localizing estimates in small areas, such as national forest working circles. The analysis also provided a working tool for determining the intensity of sampling needed to meet any required accuracy in areas of any size and make-up of age-density classes.

Forest-area data obtained in line sampling the maps was analyzed, providing preliminary charts from which can be read the sampling error of estimates of area in any mapped class for line spacings of 1, 2, or 4 miles. From this it was apparent that the use of lines spaced 2 miles apart would give results meeting the survey requirement.

In revising the inventory work plan to reflect experience as to costs, adequacy of sampling, and new procedures, the program was altered in the following respects:

(1) Field sampling requirements were reduced from 3,689 plots and locations to 3,375 plots at 1,125 locations.

(2) National parks and the relatively unimportant commercial forest land in the south Coast Range and southern California were eliminated from the field inventory. For the eliminated areas, forest reappraisal maps and other existing information will be brought up to date and utilized for inventory purposes.

(3) The area to be covered by field mapping of types and sites was reduced from 830 to 374 7½-minute quadrangles.

The age and density of timber stands were classified on a gross area of 10.6 million acres, and 10.1 million acres of this were transferred to base maps. This coverage represents about 32 percent of the total job. Approximately 24 percent of the volume-sampling job was completed by measuring 876 fifth-acre plots, sampling 3.8 million acres of commercial forest land.

Forest Survey — Drain and Requirements

Except for the study of wood used in farm construction, essentially all of the work scheduled was completed. The farm wood requirements study was deferred until additional Survey funds are available.

The drain survey showed that the amount of sawlog material taken from the California forests in 1946, by items, was as follows:

	M bd. ft.
Sawlogs milled in California	2,836,140
Sawlogs exported to Oregon	50,940
Veneer logs and bolts	48,270
Shingle and shake bolts	18,810
Cooperage logs and bolts	11,480
Redwood split products	36,410
	3,002,050

The preliminary plan was completed for estimating mortality losses from fire and natural causes other than fire (referred to collectively as non-commodity drain in the 1946 report). Work was started according to plan, and 65 percent of the job of estimating fire losses was completed and 10 percent of the job of estimating natural losses other than fire.

Census and RPS

The annual lumber census and the RPS work was carried out as planned. This terminates the Division's activity in this field since RPS has been discontinued and the lumber census will be done in the future by the Bureau of the Census. Significant findings of the 1947 Census and RPS work are:

> Annual lumber production: 2,681 million board feet, a new record and 19 percent above 1945. Number of active mills increased from 457 to 907.
>
> Estimated 1947 production: 3,200 million board feet, about 20 percent above 1946, and the number of mills, 1,130, about 25 percent above 1946.

Forest Economics Research

Problem analysis of the forest economics field was carried forward, but not completed. Two jobs not specifically included in the original plans were undertaken, both contributing to the development of an economics research program. The first was a study of costs of experimental pulpwood logging in West side Sierra second-growth stands, carried out in cooperation with Region 5, the Eldorado National Forest, and the Fibreboard Corporation. Division personnel planned the study, gave general supervision to the field work and analysis, and prepared a preliminary report on the results of the study. Besides establishing cooperative relations with an important new forest industry, this work started exploration of the economics of second-growth management.

The second job was a study of economic aspects of sugar pine management and blister rust control. It was undertaken in cooperation with Forest Management Research, Region 5, and the Office of Blister Rust Control. The overall purpose of the project was to analyze information on management and utilization of sugar pine and on control of blister rust in order to determine the circumstances under which such management and control can be justified on economic grounds. Plans for the study were reviewed and approved by an advisory committee composed

of representatives of interested federal agencies, the State Forester, the California Forest Protective Association, and sugar pine operators. In response to a recommendation of this advisory group, initial emphasis in the study was laid on a survey and analysis of existing information on markets, values, costs, and other data pertinent to the sugar pine problem. A report covering this preliminary study was completed by the end of the year.

Other Activities

In its cooperation with the State Division of Forestry, financed with State funds, the Division:

(1) Carried on the work required to obtain new aerial photography for about 10,650 square miles.

(2) Guided the expenditure of $15,000 allotted by the State to the construction of base maps needed in the Survey.

(3) Initiated the work contracted for by the State to intensify the Survey on certain areas outside the national forests by classifying the age and density of timber stands to a 10-acre minimum, by classifying vegetation types according to species composition and the predominant soil underlying each type by soil series and depth class, and by rating timberland according to site productivity classes.

Twelve people were recruited and trained for this work, including 7 that had to become proficient in aerial photo interpretation, type and site mapping, and soils identification. By the end of the year the photo-classification of timber and intermingled range and watershed land had been completed on 3/4 million acres, and field mapping of types, sites, and soils had been completed for $\frac{1}{4}$ million acres.

Field work was started in Siskiyou, Trinity, and Mendocino Counties for the cooperative ownership study with the Bureau of Agricultural Economics. The map work and ownership sample, which comprises 230 quadrangle sheets and 1,300 private owners, was completed for all of Siskiyou, Trinity, and the southern part of Mendocino County. Field cards for these private owners are ready for recording information from interviews and from questionnaires.

The manuscript for the pilot ownership study in northern Mendocino County was completed. Results from this pilot study were used in the development of procedures for the present study, which will cover the forest land of the entire State.

Jensen planned and carried out with R. N. Colwell of the University of California School of Forestry staff an experiment to test the relative merits of panchromatic and infrared-minus blue photography for forestry uses under California conditions. Preliminary analysis was advanced to the point that a decision in favor of the standard panchromatic-minus blue photography, for not only general vegetation classification but also for Forest Survey needs, could be made in time for the State photography contracts. The analysis is now being completed and an article is being prepared for publication.

The Division provided instructors for a three-weeks meeting held at Feather River under the joint sponsorship of the California Forest Protective Association, State Division of Forestry, University of California, and the U. S. Forest Service. During the first week Jensen gave instruction in use of aerial photos in timber surveys. During the second week Hasel covered modern sampling methods, interpretation and calculation of sampling error, estimation of mapped acreage, field plot techniques, growth prediction, mortality and defect estimation, and a new technique of making logging cost studies. This instruction was given to 10 lumber industry, 2 State Division of Forestry, 1 University Extension Division, and 3 Forest Service members.

In response to a request, Jensen prepared for publication in "California Fish and Game," an article presenting the system of classifying vegetation developed by the Station's Forest Survey group. The State Division of Fish and Game wanted this article to meet its need for standardizing the classification of vegetation. Subsequent correspondence has also indicated a nationwide interest in the system described.

R. Earl Storie, professor of Soils Technology, cooperated with the Forest Economics Division in developing the classification of soils being used in the State cooperative project, training the field crews for the soil classifications, and inspecting the work from time to time.

Plans for 1948

1. Forest Survey

Inventory

(a) Complete the classification of age and density of timber stands from aerial photographs for a gross area of 7.3 million acres and transfer these classifications to base maps.

(b) Complete volume sampling for 5.3 million acres of commercial forest land.

(c) Complete the area and volume compilation by punch card for 11.0 million acres of forest land, including three complete counties and portions of five others.

(d) Compile sample tree data collected through 1947 to localize volume tables and prepare curves of volume over diameter by species, site, and tree class groups.

(e) Complete volume tables and bark thickness curves for most important hardwoods, and provide assistance to Forest Management Research in deriving factors and volume tables needed primarily for Survey use.

(f) Complete field sampling and compile the estimate of mortality in the Coast Range pine and Douglas-fir subregions and of fire mortality in the entire State.

(g) Prepare plan for cruising cut-over areas in the redwood subregion adjusting existing old-growth cruises to Survey standards.

(h) Seek a method of estimating the number of owners by private ownership types and size classes, through the line sampling method.

(i) Study sampling variance for ways of reducing costs.

(j) In cooperation with Dr. Kimmey of the Bureau of Plant Industry, work out defect factors for the principal species, based on data now on hand.

(k) Release county statistical reports and subregion analytical reports as they are completed.

Drain and Requirements

(l) Convert the commodity production statistics in unit measure to equivalents in log scale, International $\frac{1}{4}$-inch rule.

(m) Prepare a detailed working plan for the evaluation of woods waste as a factor in total drain and conduct the necessary studies to obtain the desired information.

(n) Complete a detailed office report describing methods and findings of the study of wood used for residential construction and prepare suitable portions of the report for publication.

(o) Prepare estimates of container lumber requirements.

(p) Prepare estimates of lumber requirements in California for other manufacturing uses, based on national requirements studies, and information on industrial activity in the State obtained from secondary sources.

2. Forest Economics Research

Continue the study of economic aspects of sugar pine management and blister rust control, emphasizing analysis of the effect of type, site, age class, and stocking variations on the economic practicability of sugar pine management, and on the development of effective methods for classifying sugar pine areas with respect to their economic suitability for permanent sugar pine management.

3. Other Activities

(a) Continue State Division of Forestry cooperation, including:

Intensify the classification of timber cropland, range, and watershed land from aerial photographs for 5.5 million acres included under (a) of Inventory plans for 1948.

Complete the field work for type and site mapping and soils classification of 2.2 million acres.

Prepare for distribution maps (2 sheets) of 40 quadrangle units, or 1.4 million acres. In the main the first sheet of the set portrays the classifications obtained from the photos and the second the information that is added in the field.

Compile the acreages of the various classifications by ownership, for 3/4 million acres.

Complete work on aerial photography and base-map construction.

(b) Complete the analysis and preparation of an article on the relative merits of panchromatic and infrared-minus blue aerial photography for forestry purposes in California in cooperation with University of California.

(c) Keep cooperative ownership study with Bureau of Agricultural Economics abreast of field and office work in the inventory, and publish by the multilith process the manuscript for the pilot ownership study in northern Mendocino County.

FOREST UTILIZATION SERVICE
(L. N. Ericksen, Chief of Division)

Objectives

1. Seasoning of Local Woods

a. Arrange a field course in kiln drying.

b. Continue seasoning tests on white fir, start new tests on red fir.

c. Continue tests on California hardwoods, particularly some of the oaks, seeking assignment of a portable experimental kiln.

2. Wood Utilization

a. Start laboratory experiments on suitability of the oaks for veneer and plywood, similar to previous work on other hardwoods.

b. Continue study of white- and red-fir use for boxes, including tests of veneer in agricultural boxes.

c. With Region 5, develop a simple type of wood preserving plant for treating poles.

3. Industry Contacts

a. Acquaint prospective manufacturers with experimental work in veneering tanoak, madrone, California laurel, and chinquapin.

b. Continue work on utilization phases of the Antioch pulp mill, including laboratory study of pulping incense cedar.

c. Develop plans for and complete a survey of wood waste accumulating at primary plants as a guide for new industries.

d. Continue to acquaint interested users of wood with results of research in effort to improve utilization of forest products.

Activities and Accomplishments

Objectives for the year had to be modified in certain details to fit the research program of the Forest Products Laboratory, the emphasis being on seasoning white fir, utilization of white and red fir, seasoning local hardwoods, and the use of hardwoods in veneer form.

Seasoning of local woods

White Fir. - Results of experimental work in kiln drying of white fir done at the Forest Products Laboratory were discussed with a number of operators. The suggested schedules were somewhat more severe than those commonly used in the industry, but several kiln operators have advised that they were able to use the higher temperatures involved without increasing surface checking.

No further work was done on air seasoning. The report on the results of the air seasoning studies completed last year was furnished the Fruit Growers Supply Company, the cooperator. While the results were not conclusive, they did indicate less degrade in value for lumber piled by the experimental methods than for company piling practice. The experimental piling methods closed up the pile by means of 1-inch stickers, single courses, and close spacing of boards; company practice used 2-inch stickers, double courses, and wider spacing between boards.

Hardwoods. - Due to inability of the Forest Products Laboratory to assign the necessary personnel, we were unable to carry out plans to conduct experimental drying in a portable kiln in the field. The report on the work done at Madison on kiln drying California hardwoods has been passed on to a number of interested persons and the subject discussed with operators. Lacking specific information, advice on the kiln drying of local oaks has been based on Laboratory experience with eastern and southern oaks.

Dry Kiln Demonstration. - The Station arranged for a demonstration course in kiln drying, which technicians from the Laboratory gave in San Francisco in July at the plant of L. and E. Emmanuel, Inc. Nineteen students from 17 organizations attended. Represented were lumber manufacturers, wholesalers, custom dry kiln operators, and manufacturers of millwork, flooring, and cedar pencil slats. A one-day conference with managers was held in conjunction with the course. Judging from comments during the course, and inquiries received since, the course was highly effective.

Wood Utilization

White and Red Fir. - Field tests were made on two types of agricultural containers using California red-fir veneer for important component parts. The veneer was cut at the Forest Products Laboratory from logs shipped from northern California by Winton Lumber Company, Long-Bell Lumber Company, and the Associated Lumber and Box Company. When used as ends for lettuce crates it performed satisfactorily. Orange boxes were also made up, using the veneer for side and bottom slats. The principal difficulty encountered was in the automatic feed nailing machine, where even slight cupping and warping jammed the machine and caused delays. In the hand-fed nailing machine no particular difficulty was involved.

In a test shipment of oranges to the east coast, the boxes having red fir veneer slats performed about as well as the regular box having sawn ponderosa pine slats. The Forest Utilization Service Unit at the Northeastern Station inspected the boxes at destination. One California distributor, to whom a quantity of veneer slats was furnished, said that a number of his shippers are ready to use the veneer slats whenever they are available at a competitive price.

The Laboratory is continuing work on the production of rotary cut veneer for plywood from red fir. Results of the experimental work so far completed have been discussed with veneer and plywood plant operators and one indicated that he might carry the work further to a plant trial. Several slicers to cut box covers have been installed in the pine region. At least one of them is working with white fir.

Hardwoods. - During the year additional material was sent to the Forest Products Laboratory for use in experimental work in veneer production. Tanoak was furnished to continue the work started last year on it, and California black oak to determine the veneering characteristics of that wood. Results of veneer work with several hardwoods of the redwood region - tanoak, madrone, laurel, and chinquapin - have been shown to plywood manufacturers operating and planning to operate in that area. Although they showed a real interest, asking for samples of the veneer and plywood made from these woods, these operators are at present concentrating on getting into production of fir and redwood. Their active interest in the hardwoods, to the extent of actual trials, may have to wait until some of the operating problems inherent in any new plant are worked out. One operator in the pine region has expressed an interest in the possibility of producing veneer and plywood from black oak.

The cooperative job with Region 5 on development of a simple type of wood preserving plant suitable for open tank treatment of poles was carried out to the design of a typical installation. Because of market conditions, the Region did not establish such a plant, but found it more desirable to purchase commercially treated poles.

Industry Developments

The most important utilization development in California during 1947 was in the plywood field. In the redwood region two new fir plywood plants have come into production, and three more are either under construction or being definitely planned. Redwood plywood is included in the plans of some of these companies. In the pine region a small plant, possibly the forerunner of a larger installation, began operation. A large pine plywood plant is being established in the upper Sacramento Valley. The R.F.C. and banks interested in financing some of these companies have asked for information on timber resources and quality, and on questions related to plywood production.

There is continued interest in kiln drying and dry-kiln construction. We have worked with companies on kiln-drying problems, with others interested in building kilns, and with manufacturers of building materials who are interested in dry kiln buildings.

The first shipment of Philippine hardwoods to come in since the war arrived in Oakland in December, inspiring questions which will come up more frequently as more lumber comes in.

The pulp mill at Antioch, mentioned in the 1946 report, is being built. Results of the experimental work on pulping young incense cedar sent to the Forest Products Laboratory have been given to the company involved. The company is making contracts with some of the pine mills under which it will install chippers at the mills, chip material picked out of the waste conveyor, and ship the chips to the pulp mill. This source is expected to furnish a large portion of the raw material for the first unit (semi-chemical) of the mill.

Plans were crystallized for a study of waste developing at sawmills and work was done at typical mills to work out methods, units of measure, etc. Completion of the study had to be deferred when Earl Felt left the Station.

During the year the Forest Utilization Service Unit arranged for and accompanied Forest Products Laboratory workers on trips to confer with lumber and plywood manufacturers, to box factories and box assembly plants, wood treating plants, and furniture plants in the interest of better techniques in drying, gluing, assembly, and related problems. Besides personal contacts and handling requests for information from industry organizations and individuals, talks were made at several meetings of lumber groups and local business groups interested in the development of wood-using industries.

Plans for 1948

1. Seasoning of Wood

a. Follow-up experimental work on seasoning of hardwoods done at Madison, by use of a portable experimental kiln in the field.

b. Conduct experimental work on kiln drying of California black oak with same equipment.

c. If suitable cooperation can be arranged, carry out air seasoning tests on black oak and some of the other hardwoods, probably in conjunction with the kiln-drying work.

d. Follow up experimental work in seasoning white fir to check on suggested schedules.

e. If interest warrants, arrange demonstration course in kiln drying in southern California or in the pine region.

f. Investigate practicability of designing a kiln suitable both for dehydrating fruit and drying lumber.

2. Utilization

a. Continue studies of utilization possibilities of local hardwoods: veneer and lumber, properties, working qualities, etc.

b. If Forest Products Laboratory can undertake study of design and nailing of containers for fruits and vegetables, work with them on field phases of the problem.

c. Follow up with industry on experimental work on veneer and plywood from white and red fir.

d. Carry out the sawmill waste survey.

e. Encourage better utilization practices by dissemination of results of research to interested manufacturers and users of forest products.

RANGE RESEARCH

(M. W. Talbot, Associate Director, In Charge)

Work of this Division is reported upon, for convenience and clarity, by the three main activities: grazing management in the mountains, grazing management in the foothills, and reseeding.

Mountain Ranges (A. L. Hormay, Project Leader)

Objectives

1. Prepare a manuscript on the chief experimental results obtained to date at the Burgess Spring Experimental Range.

2. Carry a comparison of timber-type and meadow-type range through a fourth and probably final year and incorporate the results in the Burgess Spring manuscript; revise Research Note No. 44.

3. Collaborate with Cornelius in preparing a reseeding analysis for northeastern California.

Activities and Accomplishments

Burgess Spring Manuscript and Timber-meadow Comparison

The experimental work at the Burgess Spring Experimental Range on the cut-over pine-timber type continued in close cooperation with Region 5, the Lassen National Forest, the local farm advisor, and Pierce McClelland, owner of the experimental cattle. Results of seven years of experimental work were compiled and mostly analyzed. A limited amount of additional field data was gathered to fill gaps in the data, as revealed by the analysis. This included completing a fourth year of work to establish the general production level of cut-over pine-timber range compared with mountain-meadow range, and to check the weight gains of cattle moved between these two types during the grazing season. The results were essentially the same as those obtained in previous years.

Generally speaking, the work at Burgess Spring has shown that cut-over pine-timber range is a desirable grazing type for beef cattle and that some form of deferred grazing and close control of livestock is necessary to maintain and improve the productivity of the type and to make most efficient use of it. The work points strongly to the ultimate need of managing cattle under fence on northeastern California and comparable ranges. The placement and extent of fencing depend strongly on the gains cattle make in the different types under different methods of handling. Four years' results show definitely that cattle moved from one type to another during the season, even though they were moved to better forage, gained substantially less weight than cattle grazed in either type season-long. How will cattle gain if they have free access to limited acreages of these two types under fence control? It is important to have information on this point.

Planned revision of Research Note No. 44 to cover the second and third season's results of the timber-meadow comparison was cancelled. More formal publication seemed warranted for adequate reporting of the results, and they will be incorporated in the main Burgess Spring manuscript.

Other Activities

Assistance was given Cornelius in the preparation of a reseeding analysis of northeastern California.

The first range management summer camp in the history of the School of Forestry at the University of California was held at the Burgess Spring Experimental Range during the first two weeks of August, followed by two weeks at the San Joaquin Experimental Range. The University has long felt the need of giving range students a summer of "on the ground" instruction in range management. The 1947 sessions with four advanced students served as "feelers" to aid in deciding how and where the instruction should be given and the form it should take. At Burgess Spring, Hormay and Cornelius outlined lessons and instructed in range management, ecology, and artificial reseeding.

Hormay prepared a paper on "Forest Grazing in California" and presented it at the national meeting of the Society of American Foresters in Minneapolis in December.

Plans for 1948

1. Complete the manuscript covering the major findings at the Burgess Spring Experimental Range to date.

2. If the manuscript is completed in time, carry out one more season's work on the timber and meadow comparison, checking the weight gains of cattle that have free access to timber and meadow forage with others that are grazed season-long in each of these two types. Otherwise, limit field work to checking soundness of Burgess Spring results and general applicability in the eastside region.

3. Continue assistance in developing the artificial reseeding program in northeastern California.

Foothill Ranges (J. R. Bentley, Project Leader)

Objectives

1. Completion of manuscript covering major findings from the forage and soil phases of grazing management studies on annual-plant ranges.

2. Start of planning for next phase of research program.

3. Minimum-level continuance of studies of reseeding and fertilization, and liaison with cooperative brush-control studies.

Activities and Accomplishments

The foothill portion of the range research program has been handled chiefly from the San Joaquin Experimental Range which was established in 1934 to provide a center for concerted inter-agency attack on unsolved problems of foothill ranges of central California - both inside and adjacent to a half dozen national forests. The College of Agriculture of the University of California is the primary cooperator. Among these problems are seasonal variabilities and nutritional deficiencies of the annual-plant types of foothill range forage, which affect not only the efficient utilization of these foothill lands themselves but also land-use relationships with the higher range and watershed lands in the mountains, and with the lower cultivated zone in the valleys.

Annual-plant Range Manuscript

The manuscript "Growth and Utilization of Annual-plant Forage on California Foothill Ranges" by Bentley and Talbot, was prepared for a Departmental circular. Revision following formal review is now in progress. This circular covers 12-year (1935-46) results from the San Joaquin Experimental Range. It describes the pattern of growth and utilization of annual plants, how that pattern is influenced by weather and by site, and how forage and soil are affected by different degrees of grazing use. The application of these findings in obtaining more efficient utilization of the present annual-plant forage on California foothill ranges is stressed. Illustrative examples of findings follow:

Annual-plant forage on foothill ranges is adequate in amount and well balanced nutritionally for only four to six months each year (from late winter to early summer), but can be used efficiently at all times of the year if augmented by limited supplements. The length of the supplementary period and the amount of feed required differ with weather from year to year. Despite annual variations in periods of growth and composition of the herbage crop, the annual-plant mixture is a rather dependable source of forage, except in the driest parts of the foothill area.

Topography, soil, and extent of waste area determine grazing capacity and best season of use. Swales produce the greatest amount of herbage and it remains green about three weeks later than herbage on slopes. By grazing the different kinds of land at the season when they supply the best forage and by holding back areas in which the select forage plants are not picked over, the period of adequate, nutritious forage can be lengthened by a few weeks each year.

The grazing-intensity studies have established the importance of leaving enough dry herbage to maintain satisfactory soil-surface conditions for the best growth of the new crop of annual plants each year. Fairly light grazing promoted high yields of a desirable herbage mixture, good winter growth of forage, and good soil-surface conditions; but on ranges grazed from late winter to midsummer, light grazing leaves forage that could be efficiently used by cattle. On the other hand, close grazing resulted in lower herbage yields, slower

winter growth, and unsatisfactory soil-surface conditions with definite indications of range deterioration. Moreover, as concluded by the animal husbandmen, production from the breeding herd was not satisfactory in the closely grazed pasture. Moderate grazing was most efficient, for it maintained satisfactory soil and forage conditions and satisfactory cattle production.

Other Activities

Field work on the reseeding and fertilizer plots was held to a bare minimum. The outstanding observation during the dry year was the increase of annual-grass growth on the gypsum plot, from residual effects of nitrogen built up by previous legume crops.

Liaison with the cooperative brush-control studies was limited to photos and observations of reseeding trials on burned-over brush at the Clark Administrative Site. These results emphasize the difficulty of obtaining satisfactory clearing through fire alone and the difficulty of establishing perennials within pastures where there is a very limited amount of heavy burn. Good stands apparently can be obtained on the small "white ash" spots where competition from annuals is reduced but the stands are difficult to maintain under combined grazing of deer, rodents, and occasional livestock. This "brush" problem rates separate-project status and intensive study.

Highlights of the studies at the Experimental Range and from observations over the foothill area were presented by Bentley in a symposium on the role of annual plants on Western ranges, before the American Association for the Advancement of Science, in San Diego in June. The paper, "Annual-plant Vegetation of the California Foothills as Related to Range Management," by Bentley and Talbot, will appear in an early issue of ECOLOGY.

Results from cooperative studies since 1935 on the use of annual-plant forage by range rodents were summarized by Dr. Henry S. Fitch of the U. S. Fish and Wildlife Service and Bentley of the Station. This material, being prepared for publication, reveals significant highlights. For example, in separate pens, ground squirrels eliminated 35 percent of the yearly herbage crop, gophers 25 percent, and kangaroo rats 16 percent - where each species was near maximum local populations and had unrestricted use of the herbage. Although the percentage for each kind of rodent is undoubtedly lower under competition with other rodents and with cattle, the potential destructiveness of the different species is emphasized. More information is needed on the extent to which average mixed populations of rodents compete with cattle in grazed pastures.

A well-attended Field Day in November demonstrated to ranchers and range technicians the conclusions to date at the San Joaquin Experimental Range. In a preceding evening meeting, the cooperative research program and findings were outlined, using kodachrome slides to illustrate the appearance of the range and cattle at different seasons of the year. At the Experimental Range on November 15, emphasis was placed on results from the grazing-intensity studies during the year. Exceptional

interest was also evinced in the effect on young animals of different levels of feeding, and in results from the exploratory work on range fertilization. The evening meeting, a new innovation this year, was so well received that it will be incorporated in future Field Days. Including this Field Day, 250 persons, mostly ranchers and students, visited the Range in 1947.

A meeting of the Advisory Committee for the San Joaquin Experimental Range was held in December, to obtain stockmen's suggestions regarding the next phase of the research program. The status of work to date was briefly reviewed by members of the University and the Station. The committee recommended termination of the unsupplemented cow herd and the 6-pasture grazing-intensity experiments. Among the helpful suggestions that were presented was the strong desire for a new, full-scale study of the effects of range fertilization on forage and cattle, based on the exploratory plot studies to date. Other recommended new work included study of the use of native and introduced shrubs as browse, effects of brush and trees on herbaceous growth, and methods of brush eradication.

Plans for 1948

1. Complete revision of manuscript for Departmental circular in line with comments from Board of Review and Washington office.

2. Develop the working plan for the next phase of the joint research program at the San Joaquin Experimental Range.

3. Continue limited work on the effects of weather on annual-plant forage, effects of fertilizer on range forage, reseeding, and liaison with brush-control studies.

Range Reseeding (D. R. Cornelius, Project Leader)

Objectives

1. Check and evaluate results of last year's plantings.

2. Obtain specific bits of information needed for completion of problem analysis and development of a working plan for the State-wide range reseeding project.

Activities and Accomplishments

Specific information was obtained by continuing selected "site studies" and "species adaptation" trials, and by comparing methods and time of land preparation to reduce competition from resident weedy plants and to provide a satisfactory seed bed. This project, tied closely to the action program of Region 5, also was helped materially by consultations with the Agricultural Extension Service, the College of Agriculture, and the Soil Conservation Service. The work is not restricted to designated work centers, but may be reported by two broad areas.

Northeastern California

A satisfactory first-season stand of seedlings from field plots planted in the fall of 1946 was obtained on the sagebrush types on the Modoc and Lassen National Forests. Despite below-normal precipitation during the winter and spring season, rainfall in June favored early-summer germination and good survival for most plantings.

Crested wheatgrass of the standard strain appeared widely adapted to dry ranges with elevations of 4,000 to 5,000 feet. Smooth bromegrass gave better results with more favorable soil and moisture conditions at elevations of 5,000 to 7,500 feet. This response of species was noted in the 1947 examination of experimental plots planted by the Station at 14 locations and of 18 fields planted by Region 5 representing depleted ranges considered suitable for reseeding on the Modoc, Shasta, Lassen, Plumas and Klamath National Forests.

These preliminary plantings have also indicated still greater possibilities from new strains and species resulting from: (1) new introductions, (2) selection and domestication of native species, or (3) new strains and hybrids produced by plant breeders. Some which responded well on range plots in the sagebrush type even under the dry conditions of 1947 are: Agropyron intermedium, A. elongatum, A. trachycaulum, Elymus canadensis, Poa ampla, and Sitanion hystrix. The last four are native grasses. Agropyron intermedium and Elymus canadensis exhibited greater seedling vigor than the other species in the test.

Bitterbrush and dry-land alfalfa are being tested with the range grasses. Satisfactory emergence of these two desirable forage plants was obtained, but it is too early to determine how they will perform after the first season.

Promising first-year results were obtained in reseeding an open area of depleted range supporting black and silver sagebrush in the ponderosa pine zone on the Modoc National Forest on "adobe" soil. Smooth bromegrass rated high in this test of 25 species. Additional plots were planted in October 1947 to obtain concrete information on "strain adaptation," method of land preparation, and time of planting on eight sites in northeastern California.

Disappointing results were obtained in an attempt to reseed a meadow area on the Lassen National Forest. Neither the "Dixie drag" nor disk harrow broke up the amazingly tough mat of interwoven roots of sedges and rushes. Also, complete interpretation of results was obscured by an invasion of grasshoppers. A disk plow was used on part of the meadow in the autumn of 1947, but the seed bed was too rough to be drilled the same season. Although soil and moisture conditions are favorable, reseeding on this site will require a heavy investment in land preparation, and perhaps even a fallow or a grain crop before seeding range grasses. These facts seem to relegate this site to a lower priority for reseeding than anticipated when plots were originally laid out, and emphasizes the need for more intensive evaluation of site possibilities, by means of small-scale field plots, before attempting large-scale plantings.

To compare methods of reducing sagebrush on three different sites, the Station prepared plots with disk, plow, and mower in July and August 1947, and seeded them in October. Each site represents a large acreage of depleted range. Observation of Region 5 field plantings indicated an advantage for early summer preparation of land instead of waiting until autumn.

A 24-acre planting of crested wheatgrass made by Ranger C. A. Abell (Shasta National Forest), illustrates the possibility of materially increasing grazing capacity by reseeding. In 1947 the reseeded range produced 1,446 pounds per acre of crested wheatgrass, compared with a yield of 126 pounds per acre of mixed grasses on the adjacent unimproved sagebrush range - a 10-fold increase from reseeding. On adjoining plots, smooth bromegrass yielded 897 pounds per acre, bluebunch wheatgrass 1,226 pounds, and slender wheatgrass 1,039 pounds.

Central California

The dry year of 1947 favored growth of two native needle grasses, Stipa cernua and S. pulchra, over introduced species of grasses and legumes in nursery and field plantings at the San Joaquin Experimental Range. Rose clover, Trifolium hirtum, a legume of recent introduction, offers promise on dry sites of the lower foothill ranges.

In a preliminary comparison between summer fallow and a crop of Sudan grass, to precede the planting of range grasses, Sudan competed successfully with weeds during summer, produced a crop of hay, and provided mulch from aftermath which grew in early autumn. Sudan also was of value in controlling erosion, which is frequently a problem with fallow on sloping land. However, the use of Sudan grass had certain disadvantages, such as competition of its late-season growth with the range grass seedlings, and interference of the Sudan grass stubble with operation of seedling equipment.

An examination in November revealed a good crop of forage on an experimental planting of range grasses made initially by Ranger Spargo and supplemented later by the Station on lower portions of a depleted wet mountain meadow on the Stanislaus National Forest. Tall oatgrass, velvet grass, orchard grass, timothy, and Kentucky bluegrass are adapted to the part of the site having good soil and moisture. Further experimental work is required to establish forage plants on the upper part where erosion and a lowered water table have lowered the site.

General Trends of Preliminary Results

Fall seeding has given best results in most tests to date. On all sites it is of paramount importance to eliminate or reduce weed competition for plantings to be successful. Drilling or at least covering seed has been essential for successful seeding except in deep ash on burned-over areas. Special design of equipment is needed for rocky soil and sagebrush ranges. A method of eradicating silver sagebrush is needed because it occupies much depleted range in California that should be producing desirable forage plants, and because it does

not yield to methods that are effective on big sagebrush. Better criteria are needed for evaluation of sites for reseeding.

Plans for 1948

1. Conduct spot studies on several national forests and from the San Joaquin Experimental Range for test of selected sites, suitability of species, and methods of land preparation and seeding.

2. Incorporate this information into the State-wide problem analysis and work plan for a comprehensive reseeding project.

3. Continue to cooperate with the Agronomy and Extension Departments of the University of California, the Soil Conservation Service, and other State and Federal agencies in planning for continued coordination of range reseeding programs.

FOREST INFLUENCES
(C. J. Kraebel, Chief of Division)

Objectives

1. Fire Damage Appraisal: (a) Complete the hydrologic analyses for the remaining watershed units within the four national forests of southern California; (b) prepare reports covering vegetation, soils, geology, and hydrology for each forest; (c) prepare for publication a paper describing the method of hydrologic analysis employed in the project; (d) submit for publication a paper describing the method used for extensive surveying of forest soils.

2. San Dimas Center:

a. Continue analysis of accumulated San Dimas data.

b. Complete cover plantings on lysimeters.

c. Prepare report on rainfall studies on Monroe and Wolfskill watersheds.

d. On July 1, concentrate on a curtailed program including data analysis and publication, and meeting minimum requirements in cooperation and extension.

3. Soil Moisture Cycle:

a. Complete analysis of North Fork and Bass Lake data and combine with results of similar studies at San Dimas for publication.

b. Complete laboratory tests of the electrical soil-moisture meter and arrange for commercial production and inter-agency field tests.

4. Miscellaneous:

a. Complete the paper on brushland burning in California for departmental publication.

b. Prepare a paper on vegetation succession following fire in chamise-chaparral.

c. Complete analysis of plot data on effect of mustard sowing in burned areas and prepare results for publication. Revise and reissue Research Note 37, Directions for Sowing Mustard.

d. Continue in-service and other cooperation as far as possible without excessively retarding work on other plans.

Activities and Accomplishments

The initial objectives were modified during the last half of the year, when assistance from the State of California became available for the San Dimas Experimental Forest. Two primary objectives were agreed to

in a plan of cooperation with the State Division of Forestry, namely (1) to continue all essential hydrologic records on the Experimental Forest, and (2) to prepare for publication certain results of forest influences investigations by this Station that were mutually considered of most importance at this time. Under the revised program, work on several items was suspended and top priority was given to the preparation of material for State publication.

To expedite the reoriented objectives, additional clerical and subprofessional personnel were recruited. The technical staff were relieved of all operational responsibility except for consultation and for assisting at gaging stations during emergency storm periods. Responsibility for all record-taking and for maintenance of research installations was placed under the forest engineer.

Fire Damage Appraisal

Hydrologic analyses and erosion estimates were completed for the four national forests of southern California. Under the reorientation plan these results are being incorporated by Rowe and Storey into a report for publication, tentatively titled "Peak Runoff and Erosion from Southern California Watersheds as Influenced by the Occurrence of Fire." The results include flood frequency and erosion estimates for 256 watershed units.

Results of the analyses show that peak flows from small storms are increased on an average from 10 to 30 times the first year after a normal watershed is completely burned. The peak flows from moderate storms are increased an average of 3 to 10 times, and floods from major storms, 2 to 3 times. Complete burning of vegetation on a watershed was found to increase peak flows resulting from small storms for a period of about 20 years, those from moderate storms for 40 years, and floods from major storms for 60 years.

Annual erosion rates appear to be increased an average of 35 times the first year after complete burning of good chaparral cover. An average of 8 to 10 years is required for erosion rates to return to normal after burning. Erosion rates during the recovery period average 9 to 10 times the rates before burning. If deep gullying such as occurs in some areas is started after burning of the vegetation, the long-time erosion rates and the time required for recovery may be greater than the averages indicated.

The effects of burning, on both peak flows and erosion rates cited above, are averages for watersheds with good cover that might be subjected to complete burning. These effects may be less severe in watersheds with very sparse vegetation or in those with large barren areas.

Work on the report of vegetation, soils, geology, and hydrology for each forest was deferred under the reorientation, as was the preparation of a paper describing the method of hydrologic analysis.

A paper describing the method used for extensive surveying of forest soils was accepted for publication by the Journal of Forestry. This paper first discusses the reasons why soil surveys on wild lands have been slow in developing, compared with those on agricultural lands. It then recommends (1) planning such surveys on the basis of the management information desired, (2) mapping soils on a broad scale so as to avoid the confusion arising from variations in soil over small areas, and (3) making use of simple and direct field and laboratory methods for classifying the soils. An example is presented in the form of a soil survey conducted on the Angeles National Forest where water and erosion offer the principal management problems.

San Dimas Experimental Forest

During the winter of 1946-47 the continuity of hydrologic records was maintained only for Monroe, Volfe, Bell, and Wolfskill watersheds, and for the lysimeters and a climatic station at Tanbark Flat. Erosion measurements also were obtained from the Bell and Fern small watersheds. When assistance from the State of California became available in the fall of 1947, the collection of records was resumed over the entire Experimental Forest. The job of analyzing accumulated data was thereafter directed mainly at providing material needed for publication under terms of the cooperative agreement with the State. Nearly 300 visitors came to the Experimental Forest during the year, and about 60 man-days of staff time were devoted to them.

Precipitation. - Through the analysis of rainfall records from several of the large watersheds within the San Dimas Experimental Forest, progress was made by Hamilton toward simplification of the major rain-gage system. As a result 149 gages were discontinued and 59 were added to the system to obtain needed supplementary information. The latter include 29 facet gages, 20 ground level gages, 7 standard vertical, and 3 intensity gages. A total of 300 gages is in operation during the current winter, compared with 430 in 1945-46. Data from the vertical and tilted facet rain-gage networks in Monroe and Wolfskill watersheds were partly analyzed, but this work was deferred under the reoriented program.

Streamflow. - Progress was made on the compilation of streamflow records from the several watersheds in the San Dimas Experimental Forest, emphasizing data required for a paper on rock-storage of water for State publication. A manuscript based on analysis of Monroe watershed data, describing a method of hydrograph separation, was revised for publication.

Interception. - Data for 8 years of interception study at North Fork and 3 years at the San Dimas Experimental Forest were analyzed for publication. As an example of results, the analysis of 50 storms on the San Dimas Experimental Forest, with a total rainfall of 83.24 inches, showed the following disposition of rainfall in mixed chaparral:

67.03 inches or 81 percent of the rain reached the ground as throughfall.

6.96 inches or 8 percent of the rain reached the ground as stemflow.

9.25 inches or 11 percent of the rain was intercepted by the canopy and evaporated, making no contribution to surface runoff or ground water.

When the storms were analyzed by size classes the interception loss was found to become less as the storm magnitude increased, as illustrated in the following sample tabulation:

Storm size class	Number storms	Total rainfall	Throughfall		Stemflow		Interception loss	
Inches		Inches	Inches	Percent	Inches	Percent	Inches	Percent
.10 - .25	10	1.70	.79	46	.06	4	.85	50
.51 -1.00	14	10.28	7.69	75	.76	7	1.83	18
2.01 -6.00	9	16.05	13.09	82	1.34	8	1.62	10

Lysimeter Studies. - Cover plantings on the lysimeters and in the surrounding "buffer" areas were completed. The five species selected for this "water-use" study are Eriogonum fasciculatum, Adenostoma fasciculatum, Ceanothus crassifolius, Quercus dumosa, and Pinus coulteri. Each species was planted in 5 of the large lysimeters, 1 unconfined lysimeter, and 1 root-study lysimeter. Despite many difficulties, failures have been few, and the present stocking is satisfactory. A description of the lysimeter program and a comparison of the performance of four lysimeter types were published as Station Research Note No. 47. The comparison showed that the design of lysimeters can exert an important influence upon studies connected with them, and suggested some ways of coping with the resulting problems.

Erosion Control Planting. - The data on erosion control plantings established in the past in southern California by the Station have been analyzed by Horton. Thirty-eight species appear to have definite uses for road slope stabilization and cover improvement work. These species are mostly southern California shrubs and semi-shrubs, but some trees and grasses such as Coulter and knobcone pines, Napier grass, and giant reed are included. This analysis provided subject matter for a manuscript on erosion control planting in southern California, now being prepared.

Soil Stabilization in Burned Watersheds. - A report summarizing the analysis of runoff measurement from two 1/50-acre burned plots, one sown to mustard and one left unsown, was prepared by Gleason. Gleason participated in the first tests of mustard sowing by helicopter, and acted as observer-adviser for the Station and Region for mustard sowing by helicopter on two burned areas, in Big Tujunga and Big Dalton Canyons, Angeles National Forest. He also participated in sowing mustard seed by airplane, on the San Luis Rey burn, Cleveland National Forest.

Other Activities.- For the program of State cooperation a condensed, semi-technical report of Rowe's North Fork studies was made ready for publication, and a paper on the relation of the geology of the San Gabriel Mountains to water distribution was prepared for technical review.

Soil Moisture Cycle

Analysis of soil-moisture records from North Fork, Bass Lake, and San Dimas plots was completed and a start was made on the preparation of a manuscript intended to be a USDA Technical Bulletin by Rowe and Colman. Besides the North Fork and Bass Lake plots described in the 1946 annual report, five others on the San Dimas Experimental Forest (four were under natural chaparral vegetation and one was bare and trenched) are included in the analysis.

The paper also includes the results of a two-year study of soil-water storage in Monroe Canyon, an 860-acre watershed within the San Dimas Experimental Forest. The soil-water storage cycle was followed on 15 sites located throughout this watershed. Analysis of these data showed that, under the annual rainfall of 31 inches in each of the two years of study (an unusual coincidence), nearly four times as much water seeped through the soil into the underlying rock as was measured in the form of streamflow. Since all evaporative soil-water losses have been accounted for in the analysis, it seems a fair assumption that the excess seepage leaves the watershed via underground flow.

Laboratory tests of Colman's electrical soil-moisture instrument were completed, and the meter and soil units were redesigned on the basis of these tests. Both are now being made according to our specifications by a local manufacturer of scientific instruments. The results of the laboratory tests were described in an office report, and incorporated in a manual of instructions for use of the instrument.

During the year 42 requests were received for information about the instrument, including several from agencies outside the United States. A total of 241 soil units and 8 meters have been sold by the Berkeley Scientific Company, and most purchasers have agreed to make available to us the results of tests they are making of the instrument.

A public patent application for the instrument was submitted to the Washington office in 1946, and is now being considered by the Patent Office.

Miscellaneous

Two drafts of the paper on brushland burning were submitted to the Washington office during the year, the second draft being restricted to discussion of southern California chaparral.

Because of the reorientation of objectives, writing of the paper on vegetation succession following fire was deferred.

The revision of Research Note No. 37 as originally planned was replaced by a "Guide for Mustard Sowing in Burned Watersheds of Southern California," prepared at the request of the Regional Office for the specific use of administrative forest officers. Carrying a foreword by Regional Forester Thompson, the guide was issued in mimeographed form by the Region. Research Note No. 37 was delayed for inclusion of new information on the use of the helicopter for mustard sowing.

To minimize the damaging effect of current logging practices upon watershed conditions, Kraebel participated with Dunning and a Regional staff group in a special committee to study resources conservation on a proposed timber sale in the Kings River working circle, Sequoia National Forest. (This was the second such project, the first being in 1946.) The report of the committee and a set of "Special Instructions for the Guidance of the Forest Officer on the Proposed Sale," prepared by the committee, were approved by the Regional Forester. This sale has special significance in watershed management because it includes a reservoir (Hume Lake) and numerous wet meadows and live streams. It is important from a public relations standpoint because the working circle in which it is located is surrounded by national park lands which will bring the logging area under the scrutiny of many park visitors.

Pursuant to discussions with personnel of the U. S. Engineers and the U. S. Weather Bureau regarding snow and watershed research, these officials were taken on an inspection trip to the Teakettle Creek and Big Creek installations in the Kings River area. The party included F. L. Rhodes and R. P. Cook of the Engineers; Dr. R. W. Gerdel and W. T. Wilson of the Weather Bureau; C. J. Kraebel and E. A. Colman of the Experiment Station. Purpose of the trip was to explore the possibilities of setting up a cooperative snow and watershed study in that area, which is representative of the southern Sierra and is of special significance in the operation of the Pine Flat flood control dam now under construction by the Corps of Engineers.

As part of the in-service cooperative work, a watershed management seminar for Forest Supervisors and Rangers from the four national forests of southern California was held at Tanbark Flat on May 21 and 22, 1947. Eighteen men from the forests attended. The material presented by the Station staff at this meeting was prepared as a report entitled "Some Aspects of Watershed Management in Southern California" for use by the forests.

For the Los Angeles River Flood Control Project, Horton prepared a program of field experiments for erosion control and cover improvement work, and acted as consultant on this phase of the project. Storey examined and reported upon the geology of upper Brown Canyon with reference to the advisability of constructing stream channel barriers in this watershed.

The calendar year 1947 was one of the driest of record in southern California, with only 4.83 inches of rain being recorded at Los Angeles. Rainfall at Glendora during the year was 7.22 inches. Both spring and fall rains were extremely deficient. The influences of this drought have been apparent in decreased water yield from the mountains and by increased water use through prolonged irrigation.

A fire that seriously threatened the San Dimas Experimental Forest denuded about 150 acres in Big Dalton Canyon on July 10, 1947. This fire burned over about 130 acres in Keril Canyon, which is a small tributary of the Big Dalton situated on the east side of the drainage just below Big Dalton dam. Approximately 20 acres of the burn drain directly into Big Dalton reservoir. The first storm of the winter occurred on December 4 and 5, 1947, during which time 2.04 inches of rain were measured at Big Dalton dam. This first storm, with only moderate intensities, caused debris-laden flash runoff from Keril Canyon. An estimated 2,000 cubic yards of eroded material was deposited in Big Dalton channel below the mouth of Keril Canyon, which is at the rate of about 9,800 cubic yards per square mile of burned area.

Plans for 1948

1. Continue operation of the San Dimas Experimental Forest, including the analysis of accumulated data, as available funds permit.

2. Complete for publication the manuscripts intended for publishing by the State Board of Forestry.

3. Carry forward the preparation of other manuscripts, completing for publication:

a. The technical bulletin covering soil-water storage studies at North Fork, Bass Lake, and San Dimas.

b. Revision of Research Note No. 37 incorporating new information on the use of the helicopter.

c. New edition of the R-5 "Guide for Mustard Sowing..." to incorporate information on use of the helicopter.

4. Continue analysis of rain-gage system on the San Dimas Experimental Forest for further simplification of the job of rainfall measurement.

5. Continue the study of rainfall on slope-facets in Monroe and Wolfskill watersheds.

6. Install and test the operation of a number of fiberglas soil-moisture units in the San Dimas lysimeters and adjacent areas.

7. Prepare for distribution to forest supervisors in southern California final drafts of descriptive material compiled in connection with the hydrologic phases of the fire damage appraisal project, covering the vegetation, soils, and geology of their forests.

8. Continue cooperation, in-service and out, in the interest of a broader and better understanding and practice of good watershed management.

FLOOD CONTROL SURVEYS
(David M. Ilch, Chief of Division)

Objectives

The 1947 objectives for this Division were altered slightly during the year to accommodate revisions in survey priorities and to undertake preliminary examinations not scheduled originally. Generally, the work of the Division was directed toward:

1. Completion of unfinished surveys on the Santa Maria, San Gabriel, and Santa Ana River watersheds.

2. Assisting the Soil Conservation Service with revision of the Walla Walla River watershed survey report and participating in the new survey of the Salinas watershed.

3. Beginning a new survey on the Santa Clara River watershed.

4. Reconnaissance of Yakima River watershed.

5. Continuing advance studies on watersheds scheduled for future survey.

Activities and Accomplishments

Completion of Old Surveys

The Wrightwood mudflow report was completed in 1946, and revised following Washington office review. The recommended plan of improvement was discussed with local interests at a hearing held in San Bernardino by the Regional Forester to determine the extent of local cooperation expected in event the program is authorized. Local agencies and organizations affected by the proposed program indicated inability to meet the financial requirements recommended. The report on the hearing, together with comments of local interests, has been submitted to the Chief's office by the Regional Forester.

Santa Maria River (California) survey report was completed in October 1947 and submitted to Washington for review. Review by the Regional Office and the Soil Conservation Service necessitated subsequent revisions which are under way. The program recommended for flood control is primarily one of land treatment and land-use adjustments aimed at improving the hydrologic capacities of the watershed.

San Gabriel River (California) survey report, completed in rough draft, will be transmitted to Washington in June. The recommended program, with a total benefit to cost ratio of 1.7 to 1.0, consists of: (a) Flood control measures designed primarily for reduction of sedimentation damages and improvement of run-off disposal systems, and (b) flood control and conservation measures aimed at improvement of the agricultural and rangelands by maintaining soil resources and reducing sedimentation damages.

Santa Ana River (California) survey report was 80 percent complete in December. Lack of sufficient basic field data from the original survey in 1940 required more field work than planned last year, particularly in the valley agricultural areas. After analysis of the coordinated mountain and valley program is completed and reviewed by S.C.S. and the Regional Office the over-all report will be submitted to Washington in June. The remedial program recommended consists of measures designed to maintain and improve watershed cover, stabilize stream channels, control debris, and reduce run-off and sedimentation from mountain and valley land. The ratio of benefits to costs is 1.3 to 1.

Participation in Soil Conservation Service Surveys

Walla Walla River (Washington) survey report — specifically the wild land portion — was completed and submitted to the Soil Conservation Service for review in October. Review of the full report and appendices was made in December.

Salinas River (California) survey was begun by the Soil Conservation Service in July, and the Division assigned two conservationists to assist in developing a program on the wild lands. Sample watersheds were selected for intensive study by both agencies as a basis for determining total program requirements. Field work for the first sample area has been completed and the data analyzed for use by the Soil Conservation Service in developing an over-all program for the area studied.

Willow Creek (Washington) survey, under direction of the Soil Conservation Service, will require very little participation by the Division. Since the forest area involved is limited, one man was assigned for one week to assist in the preparation of a survey work outline which was completed in July.

New Surveys

A new survey, on the Santa Clara River in California, not originally scheduled for 1947, was started upon completion of the survey work outline in December. Collection of basic data, outlining detailed work plans, and preparation of base maps for field use have been in progress. Arrangements were made to confer with representatives of local organizations early in January before beginning field work. The purpose of the meeting is to inform local interests of the survey, of its objectives, and to enlist their aid in the collection of basic data.

Advance Studies

Work outlines were completed for the Santa Clara, Salinas, and Willow Creek surveys.

Additional material, principally hydrologic and flood damage data, has been assembled for the Willamette, Sacramento, San Joaquin, and Ventura River watersheds.

Preliminary Examinations

Late in the year the Division was notified that the Yakima River watershed was scheduled for preliminary examination this fiscal year. During November a field reconnaissance of the watershed was made jointly with the Soil Conservation Service to inspect the area and collect sufficient data for preparation of the report this winter. The report was scheduled for completion in April.

Miscellaneous

Several trips to the Pacific Northwest were made to attend meetings of the Columbia River Basin Inter-Agency Committee in connection with projects on the Willamette River.

Several conferences and field trips were made to the Arroyo Seco unit of the Los Angeles River Flood Control Project to discuss the mountain channel program and assist in selecting tributary drainages for treatment.

The Division had one representative attend the Denver meeting of the Federal Inter-Agency River Basin Sub-committee on Sedimentation in May.

A brief mimeographed statement outlining the Forest Service's part in the Department's flood control program was prepared and distributed to Regions 5, 6, and 1.

Plans for 1948

1. Preliminary Examinations

Complete preliminary examinations of Cedar and Green Rivers in Washington and Eel River in California. Assist Soil Conservation Service in preliminary examinations on the following watersheds: Palouse River, Carmel River, San Lorenzo Creek, and Arroyo Grande River.

2. Advance Studies

a. Complete survey work outline for the Willamette River.

b. Assist Soil Conservation service in the preparation of a survey work outline for the Russian River.

c. Continue maintenance of data and reference files on watersheds scheduled for investigation and survey.

d. Develop plan and procedure for the expedient investigation of flash floods at time of occurrence.

3. Surveys

a. Complete revision of reports for the San Gabriel and Santa Ana River watersheds.

b. Complete reports on Santa Clara, Ventura, and San Diego watersheds.

c. Begin new survey of Willamette River watershed.

d. Assist Soil Conservation Service in surveys of the Salinas and Russian River watersheds.

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